IUPUI

DEPARTMENT OF
MATHEMATICAL SCIENCES

SCHOOL OF SCIENCE

Indiana University–Purdue University
Indianapolis

Graduate Student Handbook

It is the responsibility of the student to read through this handbook and follow appropriate program policies and procedures.

KEEP FOR FUTURE REFERENCE

www.math.iupui.edu

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I. INTRODUCTION

This handbook describes general information, requirements, and regulations for graduate programs in the Indiana University Purdue University Indianapolis (IUPUI) Department of Mathematical Sciences leading to a Purdue University degree (M.S. or Ph.D.). Additional information regarding specific policies of the Purdue University Graduate School can be found in the Policies and Procedures Manual for Administering Graduate Student Programs.

II. MASTER OF SCIENCE PROGRAMS

A. ADVISOR INFORMATION

Each entering graduate student will be assigned a faculty advisor to assist in the selection of graduate courses and to give guidance in the program. The student will be expected in subsequent semesters to meet with this advisor to discuss course registration and receive guidance in the program, unless another advisor is suggested to the Graduate Office by the student and future advisor.

Students in a master's program will eventually need to select an advisory committee. This committee will consist of their faculty advisor and at least two other members of the faculty, representative of the student's major area of interest (usually faculty members who have had interaction with the student through class or other projects).

B. COMMON POLICIES FOR ALL MASTER'S PROGRAMS

The Master of Science (M.S.) degree typically requires two years of graduate study by full-time students and up to four years of study by part-time students. A minimum of 30 hours of course credit is required for the M.S. degree. Students may choose to pursue the M.S. degree in Mathematics with specialization in pure mathematics, applied mathematics, mathematics education, or applied statistics.

The M.S. degree tracks have common policies that all students must follow:

- At least 30 total credit hours of coursework are required.
- Any course used to meet a minimum requirement for a B.S./B.A. degree will not count for this degree.
- All course grades must be A or B with at most two grades of C.
- A minimum overall G.P.A. of 3.0 is required for graduation.
- Up to 12 credit hours of coursework earned as graduate non-degree status (prior to entering the program) may be applied to the Master's degree, contingent on faculty approval.
- More than one-half of the total credit hours of coursework used to satisfy degree requirements must be earned in residence at IUPUI.
- Substitutions in course requirements and the transfer of credits from other universities may be permitted with the approval of the Graduate Committee (see section VI (B)). .
- Students who are inactive for 3 or more consecutive academic sessions (including summers) must submit a new application.
- Students who have been inactive for more than 5 consecutive years must submit a Course Revalidation form (see section VI (B)) in order to be able to use previous courses for their degree.

C. M.S. Mathematics Curriculum Information

1. Pure and Applied Mathematics

The graduate curriculum in mathematics seeks to develop a broad and balanced perspective in the mathematical sciences, covering both the traditional areas of pure mathematics and the many interdisciplinary fields in applied mathematics. Students are encouraged to develop a deep understanding in any chosen area of pure or applied mathematics to enable them to pursue a career in either academic or non-academic settings. The student who plans to continue toward a Ph.D. degree after completion of an M.S. degree should consider the courses on which the qualifying examinations are based before preparing the plan of study for the M.S. degree.

The course plans shown below provide a guide for students. Please note that other courses not included on these lists may satisfy the plan of study requirements. Students must discuss their plan of study with their faculty advisor to determine the most appropriate coursework for their program. The master course schedule should be consulted in planning a program since some courses are offered only once a year or less. All students pursuing a pure or applied math degree should obtain a minimum of 18 credit hours in MATH subject courses.

Pure Mathematics Requirements

For a student in pure mathematics who wishes to *continue toward a Ph.D. degree* thereafter, the plan of study should include:

Functions of a Complex Variable I	MATH 53000
Real Analysis & Measure Theory	MATH 54400
Abstract Algebra	MATH 55300
Linear Algebra	MATH 55400

In addition to this, students are recommended to take any six of the following:

Numerical Analysis	MATH 51400
Introduction to Partial Differential Equations	MATH 52300
Principles of Analysis II	MATH 54500
Introduction to Differential Geometry and Topology	MATH 56200
Dynamical Systems I	MATH 56700
Elementary Topology	MATH 57100
Mathematical Physics I	MATH 57400
Probability Theory	STAT 51900

However, any additional courses from the list below are acceptable contingent on faculty advisor approval:

Boundary Value Problems of Differential Equations	MATH 52000
Qualitative Theory of Differential Equations	MATH 52200
Functions of a Complex Variable II	MATH 53100
Applied Computational Methods II	MATH 55200
Applied Computational Methods I	MATH 55900
Introduction to Algebraic Topology	MATH 57200
Topics in Mathematics	MATH 59800
Applied Regression Analysis	STAT 51200

Designs of Experiments	STAT 51400
Sampling and Survey Techniques	STAT 52200
Mathematical Statistics	STAT 52800
Elements of Stochastic Processes	STAT 53200
	Any 600 MATH/STAT/BIOS course

For a student in pure mathematics who *does not wish to continue toward a Ph.D. degree* thereafter, the plan of study should include:

Intro to Complex Analysis -OR- Functions of a Complex Variable I	MATH 52500 -OR- MATH 53000
Real Analysis & Measure Theory	MATH 54400
Abstract Algebra	MATH 55300
Linear Algebra	MATH 55400
Topology	MATH 57100
Probability	STAT 51900
Projective Geometry -OR- Geometry	MATH 56100 -OR- MATH 56200

In addition to this, students are recommended to take three additional courses (9 credit hours total) approved by their faculty advisor. Students may choose to select any courses from the "List of Acceptable Courses for All Non-Ph.D. Tracks" shown in section II (C4) as they are suitable for this program, contingent on faculty advisor approval.

Applied Mathematics Requirements

For a student in applied mathematics who wishes to *continue toward a Ph.D. degree* thereafter, the plan of study should include:

Functions of a Complex Variable I	MATH 53000
Real Analysis & Measure Theory	MATH 54400
Abstract Algebra	MATH 55300
Linear Algebra	MATH 55400

In addition to this, students are recommended to take any six of the following:

Numerical Analysis	MATH 51400
Introduction to Partial Differential Equations	MATH 52300
Principles of Analysis II	MATH 54500
Introduction to Differential Geometry and Topology	MATH 56200
Dynamical Systems I	MATH 56700
Elementary Topology	MATH 57100
Mathematical Physics I	MATH 57400
Probability Theory	STAT 51900

However, any additional courses from the list below are acceptable contingent on faculty advisor approval:

Boundary Value Problems of Differential Equations	MATH 52000
Qualitative Theory of Differential Equations	MATH 52200
Functions of a Complex Variable II	MATH 53100
Applied Computational Methods II	MATH 55200
Applied Computational Methods I	MATH 55900
Introduction to Algebraic Topology	MATH 57200
Topics in Mathematics	MATH 59800
Applied Regression Analysis	STAT 51200
Designs of Experiments	STAT 51400
Sampling and Survey Techniques	STAT 52200
Mathematical Statistics	STAT 52800
Elements of Stochastic Processes	STAT 53200
	Any 600 MATH/STAT/BIOS course

For a student in applied mathematics who *does not wish to continue toward a Ph.D. degree* thereafter, the plan of study should include:

Ordinary Differential Equations	MATH 52200
Intro to Complex Analysis -OR- Functions of a Complex Variable I	MATH 52500 -OR- MATH 53000
Real Analysis & Measure Theory	MATH 54400
Applied Computational Methods II	MATH 55200
Linear Algebra	MATH 55400
Numerical Analysis -OR- Applied Computational Methods I	MATH 51400 -OR- MATH 55900
Probability Theory	STAT 51900

In addition to this, students are recommended to take three additional courses (9 credit hours total) approved by their faculty advisor. Students may choose to select any courses from the "List of Acceptable Courses for All Non-Ph.D. Tracks" shown in section II (C4) as they are suitable for this program, contingent on faculty advisor approval.

2. APPLIED STATISTICS

Applied statistics is the science of collecting, organizing, and interpreting numerical data. Statistical methods and procedures enable decision-making in scientific, medical, industrial and economic contexts, while statistical theory provides the mathematical basis for such procedures. While modern computers greatly facilitate applications of statistical techniques, they do not ensure that these methods will be applied correctly. The increasing use of statistical methods in many real life applications dictates a growing need for well-trained applied statisticians who thoroughly understand the procedures with which they work.

The Program

The Department of Mathematical Sciences at IUPUI offers a graduate program leading to the Purdue University Master of Science (M.S.) degree in Mathematics with a specialization in Applied Statistics. This program is designed to increase the number of professionals with the broad training in statistical methodology that is suitable for applications in industry, medicine, business and government. A typical student in this program will be exposed to a broad base of practical techniques and applications from a wide variety of fields. At the same time the student's background in theory is developed so that the learning process will continue in any professional environment pursued after graduation.

The primary goal of the master's degree program is to provide a basis for the skilled and competent application of modern statistical methods. In addition to the basic theoretical foundations, areas of methodology include regression analysis, design of experiments, multivariate analysis, quality control, survival analysis, time series, sample surveys, categorical and nonparametric methodology. All applied courses use and emphasize the importance of modern statistical computing software. Most courses are offered in the late afternoon or evening to accommodate students who are engaged in professional development while maintaining full-time careers.

Requirements for the Degree

The coursework must include the 15 credit-hour core curriculum as stated below. Further credits must conform to a Thesis or Non-Thesis option. Finally, each student must pass a written and an oral comprehensive examination.

Core Curriculum:

Applied Regression Analysis	STAT 51200
Design of Experiments	STAT 51400
Probability Theory	STAT 51900
Applied Multivariate Analysis	STAT 52400
Mathematical Statistics	STAT 52800

After successful completion of the "Core Curriculum," students are expected to take the Comprehensive Examination.

Additional Statistics Coursework:

Statistical Quality Control	STAT 51300
Statistical Consulting Problems	STAT 51500
Time Series and Applications	STAT 52000
Statistical Computing	STAT 52100
Sampling and Survey Techniques	STAT 52200
Categorical Data Analysis	STAT 52300
Bayesian Statistics and Applied Decision Theory	STAT 52900
Elements of Stochastic Processes	STAT 53200
Nonparametric Statistics	STAT 53300
Introduction to Survival Analysis	STAT 53600
Topics in Statistical Methods	STAT 59800

Option I – Non-Thesis. At least 9 credit hours must be taken in Statistics coursework beyond the core curriculum. The remaining 6 credit hours of coursework may be taken in Mathematics or in areas related to Statistics, subject to the approval of the faculty advisor.

Plan of Study:
Core Curriculum: 15 credit hours
Additional Statistics Coursework: 9 credit hours
Additional Related Coursework in Statistics, Mathematics, or related areas: 6 credit hours
Total: 30 credit hours

Option II – Thesis. A 6-credit written thesis must be submitted for an oral defense. Enrollment in six credit hours of STAT 69800 Research M.S. Thesis is permitted during the writing of the thesis. The thesis topic must be approved by the student's advisor. Also at least 6 credit hours must be taken in Statistics coursework beyond the core curriculum. The remaining 3 credit hours of coursework may be taken in Mathematics or in areas related to Statistics, subject to the approval of the faculty advisor.

Plan of Study:
Core Curriculum: 15 credit hours
Additional Statistics Coursework: 6 credit hours
M.S. Thesis STAT 69800: 6 credit hours
Additional Related Coursework in Statistics, Mathematics, or related areas: 3 credit hours
Total: 30 credit hours

Comprehensive Examination:

In addition to the above coursework, each student (thesis and non-thesis) must pass a written and oral comprehensive examination over the material in the core courses. The exam should be taken *immediately after* successful completion of the "Core Curriculum" stated above. The purpose of the exam is to motivate students to review all materials they have learned in various courses, to develop an overall perspective as a statistician and to demonstrate their individual thought processes and creativity in problem solving. It is important that students not wait to take this exam until their final semester as this could cause delays in graduation. When ready to take the comprehensive exam, students should contact the Exam Coordinator.

The exam is given twice a year, at the beginning of the fall and spring semesters (usually the Friday before the start of the semester as well as the Friday during the first week of classes). It consists of three parts:

1. An in-class written exam on theory covering STAT 51900 and 52800
2. A take-home written exam on application covering STAT 51200, 51400 and 52400
3. An oral exam on application and communication skills, based primarily on the take-home exam

Some sample exams can be found on the Math Department website.

At the conclusion of the oral exam, the examining committee will determine the result of the comprehensive exam and notify the student. A student failing any portion of the exam will have a second attempt to appear in the portion(s) s/he failed.

Ph.D. Mathematics students with emphasis in Statistics wishing to earn an M.S. in Mathematics-Applied Statistics may be waived from taking the Applied Statistics Comprehensive Examination if they pass all four of the Ph.D. Qualifying Examinations (MATH 54400, 55400, STAT 51900 and 52800). If Ph.D. students do not complete all four qualifying exams but pass the qualifying exams in STAT 51900 and 52800, they may take the applied portion only of the comprehensive exam as a part of the M.S. degree requirements. If both STAT 51900

and 52800 qualifying examinations are not successfully completed, students will be required to take both the theory and applied portions of the comprehensive exam.

3. MATHEMATICS EDUCATION

The Department of Mathematical Sciences at IUPUI offers a graduate program leading to the Purdue University Master of Science (M.S.) degree in Mathematics with a specialization in Mathematics Education. This program is designed for the mathematics teaching professional who would like to strengthen or enhance his/her mathematics background while completing a graduate degree. The curriculum is structured around the Indiana Professional Standards Board's competencies for high school mathematics teachers. The program aims to provide students with broad experiences in the range of applications of mathematics, and help students extend and formalize their thinking and reasoning skills.

Students in this program will complete a core curriculum that includes courses in abstract algebra, analysis, geometry, discrete mathematics, and probability and statistics. In addition, a student will choose from a variety of mathematics electives, as well as participate in seminars and develop an individual project involving innovative pedagogy, such as the use of technology in the mathematics classroom.

Most courses are offered in the late afternoon or evening or during the summer to accommodate students who are engaged in professional development while maintaining full-time teaching careers.

Requirements for the Degree

To fulfill the degree requirements for the Master of Science in Mathematics with specialization in Mathematics Education, the student must complete the following:

Core Requirements (18 credits): One course from each of six required areas*:

Abstract Algebra	MATH 50500
Analysis	MATH 54700 or 50400
Geometry	MATH 56100 or 56300
Discrete Mathematics	MATH 51800
Probability	STAT 51600
Statistics	STAT 51700

*Note that more advanced courses in each of the stated areas may also satisfy the Core Requirements.

Math Electives (6 credits): Two additional courses from the following list (or any other course found on the "List of Acceptable Courses for All Non-Ph.D. Tracks" shown in section II (C4) contingent on faculty advisor approval):

Complex Analysis	MATH 52500
Applied Mathematics	MATH 54900
History of Mathematics	MATH 58300
Logic	MATH 58100
Mathematics Education Seminar	MATH 59800*

*This seminar requires a project involving innovative pedagogy, such as the use of technology in the mathematics classroom. For more information and to register for this course, contact your faculty advisor.

Electives (6 credits): Two advanced courses in a related area of mathematics, mathematics education, psychology, or education that are approved by the student's faculty advisor or committee.

4. LIST OF ACCEPTABLE COURSES FOR ALL NON-PH.D. TRACKS

The list of courses below can be used for all master's programs that follow non-Ph.D. tracks, contingent on faculty approval.

Numerical Analysis	MATH 51400
Advanced Discrete Mathematics	MATH 51800
Boundary Value Problems of Differential Equations	MATH 52000
Qualitative Theory of Differential Equations	MATH 52200
Introduction to Partial Differential Equations	MATH 52300
Complex Analysis	MATH 52500
Principles of Mathematical Modeling	MATH 52600
Advanced Mathematics for Engineering and Physics II	MATH 52800
Functions of a Complex Variable I	MATH 53000
Functions of a Complex Variable II	MATH 53100
Theoretical Mechanics	MATH 53500
Applied Mathematics for Scientists and Engineers I	MATH 53700
Real Analysis & Measure Theory	MATH 54400
Principles of Analysis II	MATH 54500
Introduction to Functional Analysis	MATH 54600
Applied Computational Methods II	MATH 55200
Abstract Algebra	MATH 55300
Linear Algebra	MATH 55400
Applied Computational Methods I	MATH 55900
Projective Geometry	MATH 56100
Introduction to Differential Geometry and Topology	MATH 56200
Advanced Geometry	MATH 56300
Dynamical Systems I	MATH 56700
Elementary Topology	MATH 57100
Introduction to Algebraic Topology	MATH 57200
Mathematical Physics I	MATH 57400
Mathematical Modeling of Physical Systems I	MATH 57800
Mathematical Logic I	MATH 58500
General Set Theory	MATH 58700
Mathematical Modeling of Physical Systems II	MATH 58800
Topics in Mathematics	MATH 59800
Applied Regression Analysis	STAT 51200
Design of Experiments	STAT 51400
Probability Theory	STAT 51900
Sampling and Survey Techniques	STAT 52200

Mathematical Statistics	STAT 52800
Elements of Stochastic Processes	STAT 53200
	Any 600 MATH/STAT/BIOS course

D. Plan of Study

Each graduate student must file a plan of study with the IUPUI Graduate School. The plan of study form is found in section II (H) of this handbook. A plan of study must be submitted and approved by the department and the IUPUI Graduate School as early as is feasible in the student's study, but before the semester in which the student expects to receive the degree (December 1 for May graduates, April 1 for August and December graduates). Students in the M.S. Mathematics Applied Statistics program should submit their plan of study by the dates listed above *and* at least one month prior to their comprehensive examination. It is desirable that the plan of study be submitted by the end of the second semester of graduate study. The form must be typed and signed by all the members of the advisory committee and the Director of Graduate Programs. The advisory committee should contain three or four faculty members, representative of the student's major area of interest. The chair will be the student's faculty advisor.

The plan of study will not be approved until all technical and unsatisfied academic conditions of admission have been met. Warning: For graduate students at IUPUI, it occurs in every semester that students do not meet all the conditions of admission when they are about to graduate. The admission conditions are listed in the acceptance letter from the Purdue Graduate School (and sometimes the Office of International Affairs for international students) when students are accepted to the graduate program. Students must take care of these conditions as early as possible to avoid these problems just before graduation.

The plan of study must meet all of the "Common Policies for All Master's Programs" noted in section II (B). Any change to the plan of study must be noted on the Request for Change to the Plan of Study found in section II (H) of this handbook.

E. Final Examination

All students must pass a final examination.

Students in the M.S. Mathematics Applied Statistics program must pass the required comprehensive examination over the program's core courses. See section II (C2) for specific details regarding this exam.

For students in the M.S. Mathematics programs with specialization in Pure and Applied Mathematics and Mathematics Education, the final examination will consist of a conference of the student's advisory committee, held in absence of the candidate.

F. Candidacy and Graduation Requirements

All degree candidates must apply for graduation before the deadlines specified by the School of Science Dean's Office: typically May 1 for December graduation, October 1 for May graduation, and February 1 for August graduation. In addition to this, students must register for candidacy CAND 99100 during the session of graduation. CAND 99100 is a 0-credit hour course that signals the IUPUI School of Science Dean's Office of the student's intent to graduate. Failure to register for this course may result in a delay in graduation.

Along with registration for CAND 99100, all students must enroll in a minimum of one credit hour in their final semester. Contact a faculty advisor for course options. If no further courses are needed for the degree, CAND 99300 registration alone may be an option. This may be the case for students who have completed all coursework but delayed graduation due to insufficient completion of the final examination or other graduation requirements. See advisor and Graduate Programs Coordinator for details and to determine eligibility.

G. Normal Progress and Termination

The average time for completion of an M.S. degree is two academic years for a full time student (6-9 credit hours of coursework per semester) and approximately three to four academic years for a part time student (3-6 credit hours of coursework per semester).

Since an overall GPA of 3.0 out of 4.0 is required by the department for graduation, a student is automatically considered to be on academic probation if at any time the cumulative index falls below 3.0. Two semesters of work under the 3.0 index will generally result in the loss of program financial support such as teaching and research assistantships if applicable. Moreover, after two semesters of work under the 3.0 index, students will not be permitted to register for additional courses without permission from the Department Chair in consultation with the Director of Graduate Programs.

In addition to academic success, students are responsible for reading and abiding by the Student Code of Conduct. If students do not abide by the Student Code of Conduct, they may face disciplinary action which includes, but is not limited to, dismissal from their academic program.

If students find it necessary to withdraw from the graduate program, then they should provide as much notice as possible to the Director of the Graduate Program. In the case of teaching assistants, students are expected to complete the semester once it has begun. Similarly, the department will provide a student with as much advance notice as possible if the student is dropped from the program for reasons of poor performance.

H. Program Forms and Paperwork

Throughout the period of enrollment in the master's program, certain forms must be filled out at specified points in the program. It is the student's responsibility to complete the forms at the appropriate times, as required. Below is a list of all required forms with an explanation. All forms are available at the Purdue University Graduate School website and must be submitted to the Graduate Programs Coordinator in the Math Department.

Master's Plan of Study (Form GS-6)

Specific details of the Master's Plan of Study can be found in section II (D). See the Instructions for Submitting the Plan of Study before submitting this form to the Graduate Programs Coordinator.

Request for Change to the Plan of Study (Form GS-13)

The Request for Change to the Plan of Study form must be submitted if anything on the previously approved plan of study changes, such as an advisory committee member, a course not completed or completed in a different semester than originally planned, etc. This form must be signed by the student and approved by the major professor and the Director of Graduate Programs. The form should be submitted to the Graduate Programs Coordinator by the beginning of the semester of graduation.

Report of Master's Examining Committee (Form GS-7)

The Graduate Programs Coordinator in the Math Department will submit the Report of Master's Examining Committee form during the student's session of graduation or upon successful passing of the final examination, whichever is first. The examining committee will consist of the student's advisory committee on the plan of study. Prior to submitting this form to the IUPUI Graduate School, the student's plan of study must have been received and approved by the Graduate School.

Thesis Acceptance (Form GS-9)

The Thesis Acceptance form is for M.S. Mathematics students with concentration in Applied Statistics who are on thesis track. In addition to the electronic Form GS-9 required upon electronic thesis deposit, an "original" Form GS-9 must be printed and signed by the members of the final examination committee and the Director of Graduate Programs.

III. Doctor of Philosophy Program

A. Advisor Information

Each entering graduate student will be assigned an initial advisor from the Graduate Faculty to assist in the selection of graduate courses and to give guidance in the program. The student will be expected in subsequent semesters to meet with this advisor to discuss course registration and receive guidance in the program until a dissertation or Ph.D. advisor is selected by the student and reported to the Graduate Office.

After successful completion of the qualifying examinations (see section III (C)), students in the Ph.D. program will arrange for an advisory committee of three or four members of the Graduate Faculty representative of the student's major area of interest. At least one of those faculty members will need to be a member from the Purdue University West Lafayette Department of Mathematics. The student's Ph.D. advisor will typically serve as the Chair of the advisory committee. This advisory committee will typically oversee the student's Preliminary Examination and Final Examination. See sections III (H) and III (J) for further details.

B. Common Policies for All Ph.D. Programs

The Doctor of Philosophy (Ph.D.) degree typically varies in length depending on the student's academic background and whether a full-time or part-time course load is taken. A minimum of 90 credit hours of coursework is required for the Ph.D. degree. Students may choose to pursue the Ph.D. degree in Mathematics with specialization in pure mathematics, applied mathematics, or statistics.

The Ph.D. degree tracks have common policies that all students must follow:

- At least 90 credit hours of coursework are required.
- At least 42 credit hours of Purdue graduate coursework taken at IUPUI or Purdue University are required.
- All course grades must be A or B with at most two grades of C. All core courses must be completed with a minimum grade of B-.
- Students who have been inactive for more than 5 consecutive years cannot use previous courses for this degree. A preliminary examination passed prior to such a period of inactivity is invalid.
- A minimum overall G.P.A. of 3.0 is required for graduation.
- Up to 30 credit hours of coursework earned as a part of a master's degree from an accredited university may contribute toward the 90 credit hours of coursework required for the degree contingent on faculty approval.

- At least one-third of the total credit hours of coursework used to satisfy degree requirements must be earned (while registered for doctoral study) in continuous residence at IUPUI.
- All Ph.D. students must complete the standards as described in sections III (C-K) of this handbook:
    - Qualifying Examinations
    - Core Course Requirements
    - Foreign Language Examination
    - Plan of Study
    - Advanced Topics Examination
    - Preliminary Examination
    - Dissertation/Thesis
    - Final Examination
    - Candidacy and Graduation Requirements

C. QUALIFYING EXAMINATIONS

The student must pass four written examinations as described below. The exams are based on material covered in the courses listed below and on material from undergraduate prerequisites. See the Syllabus for Qualifying Examinations in section VII. Credit for passing a similar examination at another university cannot be transferred.

The Qualifying Examinations are written examinations offered twice a year during week long qualifier exam sessions taking place the week before classes start in August and January. Each examination is a three hour test written and graded by an IUPUI faculty member or a committee of faculty members chosen by the Graduate Committee. The exams are given grades of A, B, C, or F with B or better being pass and C or worse being fail.

The Qualifier deadline for students who enter the program with a master's degree or equivalent is 1.5 academic years after admission to the program. The Qualifier deadline for students without a master's degree is 2.5 academic years after admission to the program. If students have not passed the four exams by the session of their Qualifier deadline, they will have their privileges to continue in the Ph.D. Mathematics program terminated.

Each Qualifier Exam can be attempted a maximum of three times and students may attempt as many Qualifier Exams as they wish at any Qualifier session on or before their Qualifier deadline. Incoming students are welcome to attempt Qualifying Exams in the session preceding their first semester of enrollment (August for Fall admits and January for Spring admits). This exam attempt will not count against the maximum of three attempts permitted.

Qualifying Exam grades will not be part of your transcript. Once an exam is passed, it cannot be retaken to improve the grade from B to A.

Students must pass a suite of four qualifying exams. They must select at least two out of four subject areas from the Core 4 with at least one being either Real Analysis (MATH 54400) or Abstract Algebra (MATH 55300). They must also pass two additional exams from either the remaining Core 4 or the Area Exams.

The Core 4 subject areas are:

- Complex Analysis (MATH 53000)
- Real Analysis (MATH 54400)
- Abstract Algebra (MATH 55300)
- Linear Algebra (MATH 55400)

The Area Exams subject areas are:

- Numerical Analysis (MATH 51400)
- Probability (STAT 51900)
- Partial Differential Equations (MATH 52300)
- Differential Geometry (MATH 56200)
- Topology (MATH 57100)

Students in the **Ph.D. Math program with emphasis in Statistics** are expected to take the following exams to meet the qualifier requirement:

- Real Analysis (MATH 54400)
- Linear Algebra (MATH 55400)
- Probability (STAT 51900)
- Mathematical Statistics (STAT 52800)*

*The STAT 52800 Mathematical Statistics qualifying exam is only available for students in the Ph.D. Math program with emphasis in Statistics.

D. CORE COURSE REQUIREMENTS

All students pursuing a Ph.D. in Mathematics (Pure, Applied, or Statistics focus) are required to successfully complete the following courses unless satisfied by a successfully completed Qualifying Examination (NOTE: Courses taken outside of any Purdue University campus will not satisfy these requirements):

1. Four core* MATH subject courses from the following list:

Introduction to Complex Variables I	MATH 53000
Real Analysis & Measure Theory	MATH 54400
Abstract Algebra	MATH 55300
Linear Algebra	MATH 55400

*All core courses must be completed with a minimum grade of "B-" (or the corresponding Qualifying Exam must be passed in lieu of taking the course) prior to the Preliminary Examination (section III (H)).

2. At least two MATH or STAT subject courses from the following list:

Numerical Analysis	MATH 51400
Partial Differential Equations	MATH 52300
Differential Geometry	MATH 56200
Elementary Topology	MATH 57100
Introduction to Algebraic Topology	MATH 57200
Introduction to Probability	STAT 51900

3. In addition to the previously stated courses, students should take at least three courses (9 credit hours of coursework) at an advanced level in their field of specialty or closely related to it. Advanced reading courses and seminars (MATH 59800 or STAT 59800) may be included if a letter grade was earned.

4. Students must take a minimum of 42 credit hours of Purdue graduate coursework in Mathematics, Statistics, or a related field taken at IUPUI or Purdue University. The 42 credit hours of Purdue graduate

coursework may include advanced Reading and Topics courses (MATH 59800 and STAT 59800); however, it does not include research (MATH 69900). The 42 credit hours of Purdue graduate coursework may also include Purdue Master's graduate coursework completed at IUPUI or Purdue University. However, the Master's coursework should not be listed on the plan of study (see section III (F)). All 42 credit hours of Purdue graduate coursework must be completed with a letter grade.

5. Students should consult with their advisor to determine additional courses to take for their Ph.D. program.

6. For students in Applied Mathematics, at least two courses selected from MATH/CSCI 51400, 51500, 61400, 61500, and one course that uses advanced mathematics, taken outside the mathematical sciences.

Once students determine their course plan, they should submit a plan of study (see section III (F)) to the Graduate Programs Coordinator as soon as possible but no later than two months prior to the Advanced Topics Examination (see section III(G)).

E. FOREIGN LANGUAGE EXAMINATION

The student must satisfy the foreign language requirement in one of French, German, or Russian. Students will prove their proficiency in the language by translating mathematical literature. The examination will be given by the Department of World Languages and Cultures or by a faculty member who is proficient in French, German, or Russian. If the student's native language is one listed above, the student may be exempted from this requirement. The foreign language requirement is to be met by the student's Advanced Topics Examination deadline as described in section III(G) below. In special cases, the Graduate Committee may grant an extension of this deadline. Once students have satisfied the foreign language requirement, the coordinator of the exam should complete the Report of Foreign Language Examination and submit to the Graduate Programs Coordinator. The Report of Foreign Language Examination form can be found in section III (P) of this handbook.

F. PLAN OF STUDY

Each student must create a plan of study to be submitted to the Graduate Programs Coordinator at least two months prior to the Advanced Topics Examination (see section III(G)); though, it is preferred that the plan of study be submitted at least one semester prior to the Advanced Topics Examination. The Graduate Programs Coordinator in turn will submit the plan of study to the Purdue Graduate School for final approval. The plan of study form is found in section III (P) of this handbook.

The student must arrange for an advisory committee to approve the plan of study, with student's Ph.D. advisor serving as the Chair. This advisory committee must contain at least three faculty members. At least half of these members must have a faculty appointment over 50% in the Department of Mathematics. Also, at least one member of the advisory committee must be a professor in the Department of Mathematics at Purdue University West Lafayette. Substitutions in course requirements and the transfer of credits from other universities may be permitted with the approval of the advisory committee and the Graduate Committee.

The plan of study must include:

1. The core course requirements as stated in section III (D1-4).
2. All other applicable courses (only those graduate courses with a letter grade) should be listed on the plan of study with the exception of research courses and any courses used for a Master's degree. A completed plan of study may only include courses with grades of A or B with at most two grades of C.

3. If coursework from a Master's degree is to be counted towards the Ph.D. degree, students must have their Ph.D. advisor include a note on their plan of study indicating that a specified number of Master's credit hours will be applied toward the Ph.D. A statement such as "30 Master's credits to be applied to this Ph.D. program" with advisor's initials is sufficient.

Additional notes about the plan of study:

1. A total of 90 credit hours of coursework are required for the Ph.D. degree. This total includes thesis research (MATH 69900), as well as up to 30 credit hours of Master's coursework, all of which are not included on the plan of study.
2. An overall GPA of at least 3.0 is required.
3. The list of course offerings should be consulted in planning a program since several courses are offered only once a year or less frequently.

G. ADVANCED TOPICS EXAMINATION

A student becomes eligible to take the Advanced Topics Examination after passing the Qualifying Examinations and completing the Core 4 courses with a minimum grade of B- (or have passed the corresponding qualifying exam in lieu of taking the course). The Core 4 courses are MATH 53000, 54400, 55300, and 55400. An approved Ph.D. Plan of Study must be on file with the Graduate School in order for the Advanced Topics Examination to take place. The Advanced Topics Examination serves as the Preliminary Examination in the Department of Mathematics Ph.D. program (see section III (H)).

After passing the Qualifying Examinations, a student must find a faculty member willing to serve as the Advanced Topics Examination Coordinator. This Coordinator, once identified, begins to serve as the student's faculty advisor, counseling the student. Usually the Coordinator becomes the student's dissertation or Ph.D. advisor, provided the student passes the Advanced Topics Examination.

The student must meet with the Advanced Topics Examination Coordinator to prepare an Advanced Topics Examination Proposal Form (see section III (P)) which is to be submitted to the Graduate Programs Coordinator in the Department of Mathematics at least two months prior to the examination date. The form lists the exam coordinator, two courses beyond the qualifying level on which the student is to be examined (or a body of mathematics roughly equivalent to this), and one other faculty member who, with the exam coordinator, administers the Advanced Topics Examination. At the discretion of the exam coordinator, the examination may also cover a third subject, possibly with a third examiner.

If the Advanced Topics Examination will serve as the Preliminary Examination (in most cases it will), the committee must contain at least three members of the Graduate Faculty with at least one member from the Purdue University West Lafayette Department of Mathematics. The chair of this committee should become the student's Ph.D. advisor after successful completion of the exam. At least half of the members of the advisory committee must have a faculty appointment over 50% in the Department of Mathematics. This advisory committee may be the same or different from the committee on the plan of study.

The Advanced Topics Examination is an oral examination. The conditions of the exam are specified on the Advanced Topics Examination Proposal Form, which must be approved and signed by the exam coordinator, the student, and the Director of Graduate Programs. To pass the examination requires agreement of all members of the committee and the consent of one to serve as the student's Ph.D. advisor. While this is usually the exam coordinator, it need not be.

A student may take the Advanced Topics Examination at most twice; however, the examination should be passed within 1.5 years of passing the Qualifying Examinations. In special cases the Graduate Committee may

grant an extension of this time limit. Each time the examination is taken, a new Advanced Topics Examination Proposal Form must be submitted to the Graduate Programs Coordinator in the Math Department.

H. PRELIMINARY EXAMINATION

The Advanced Topics Examination serves as the Preliminary Examination in the Ph.D. program. Purdue Graduate School regulations require that at least two sessions of enrollment (including summer sessions) must elapse between the Preliminary Examination and the Final Examination (thesis defense). This means that if a Preliminary Exam is passed during a spring semester, the student would need to enroll during the following summer and fall semesters in order to be eligible to hold the Final Examination (see section III (J)) the following spring.

A request form for the Preliminary Examination (see section III (P)) must be submitted to the Graduate Programs Coordinator at least two months prior to the examination date and after the Plan of Study is on file with the Purdue Graduate School. The Graduate Programs Coordinator in turn will submit the request form to the Purdue Graduate School. In the case where the Advanced Topics Examination (see section III (G)) is used as the Preliminary Examination, the Graduate Programs Coordinator will complete this form for students after the Advanced Topics Proposal Form is received.

The advisory committee for the Preliminary Examination must contain at least three members of the Graduate Faculty with at least one member from the Purdue University West Lafayette Department of Mathematics. The chair of this committee should become the student's Ph.D. advisor after successful completion of the exam. At least half of the members of the advisory committee must have a faculty appointment over 50% in the Department of Mathematics. This advisory committee may be the same or different from the committee on the plan of study.

If a student has an advisor who is not in the Department of Mathematics, an advisory committee must be approved by the Graduate Committee of the Department of Mathematical Sciences. In this case, a preliminary examination separate from the Advanced Topics Examination may be required. The purpose of this exam is to ensure that the proposed thesis project is chiefly mathematical in nature, and that a thesis on this topic is appropriate as a thesis in the Department of Mathematics. A report on the preliminary examination shall be made in writing to the Graduate Committee of Mathematics. The report must discuss the proposed project, with particular emphasis on the mathematical content. The Graduate Committee will then make the final decision whether the dissertation topic is acceptable.

I. DISSERTATION/THESIS

A Ph.D. dissertation/thesis is a document authored by an individual, describing results of original research undertaken by that individual, and asserting a position which that individual is willing to defend. A dissertation/thesis must be submitted in final form presenting new results of sufficient importance to merit publication.

The dissertation/thesis must meet departmental and University format requirements. See the Purdue Thesis/Dissertation Office site for guidelines.

Thesis Formatting and Deposit

It is very important that all students in the Ph.D. program attend a Thesis Workshop upon successfully completing the Advanced Topics or Preliminary Examination. The Thesis Workshop is meant to provide the tools and guidelines for formatting a thesis and providing information on when to deposit a thesis. A late thesis deposit could delay graduation. Therefore, it is very important to be informed about this process.

The IUPUI Graduate Office and the Purdue University Graduate Office provide representatives each semester to present information on Thesis Formatting and Deposit guidelines. Information regarding these workshops will be sent by the Graduate Office via IUPUI email.

Please visit the Purdue Thesis/Dissertation Office site for further details on the thesis process.

J. Final Examination

A Request for Appointment of Examining Committee (see section III (P)) signed by the Ph.D. advisor and the Director of Graduate Programs, must be received by the Graduate Programs Coordinator at least two months prior to the proposed examination date. The Graduate Programs Coordinator in turn will submit the request to the Purdue Graduate School. The committee consists of a minimum of four members of the Graduate Faculty, at least one of whom must be from the Purdue University West Lafayette Department of Mathematics. At least half of the examining committee must have a faculty appointment over 50% in the Department of Mathematics. This committee may contain the same or different members from the committee for the Preliminary Examination. Final examinations must be held by the Purdue University Graduate School deadline.

The dissertation/thesis must be accepted by the Ph.D. advisor, and four copies must be submitted to the members of the examining committee at least three weeks before the date of the final examination. An electronic copy should also be provided to the Graduate Programs Coordinator for dissemination to the Math Department faculty, staff, and graduate students. The student must present the contents of the dissertation or thesis before the examining committee in an open colloquium or seminar.

Following a successful final examination, the complete and corrected deposit copy of the dissertation/thesis, including the completed Thesis Acceptance (Form 9), the Dissertation Agreement, Publication Delay, and Certification/Disclaimer (Form 32), the Survey of Earned Doctorate Certificate of Completion, and Cover Page for Electronic Thesis Deposit (Form 30) must be delivered to the Purdue Thesis/Dissertation Office by the appropriate deadline. Prior to the final examination, doctoral candidates should schedule a long-distance deposit appointment with the Purdue Thesis/Dissertation Office to take place after the completion of the final exam (usually 1-2 weeks later but before the deposit deadline to allow for revisions to the dissertation as needed).

See the Purdue Thesis/Dissertation Office for additional information.

K. Candidacy and Other Graduation Requirements

All degree candidates must apply for graduation before the deadline specified by the School of Science Dean's Office. In addition to this, students must register for candidacy CAND 99100 during the session of graduation. CAND 99100 is a 0-credit hour course that signals the IUPUI School of Science Dean's Office of the student's intent to graduate. Failure to register for this course may result in a delay in graduation. Students must also be registered for *at least one credit hour in the session of graduation*. Those with outstanding incomplete grades for courses listed on the plan of study will not be permitted to graduate.

CAND 99300 may be an option for students not needing any additional coursework or research hours towards their degree. Enrollment in this course may only occur one time during the degree and requires an early exam and deposit date. See the Graduate Programs Coordinator for more information on eligibility.

Ph.D. candidates must submit the form 380-Request to Have Degree Awarded at Another Campus to the Graduate Programs Coordinator at least one semester prior to graduation. The Graduate Programs Coordinator will then forward the form to the IUPUI School of Science Dean's Office for submission.

L. Time Limits for the Completion of the PH.D.

Seven years from entry into the graduate program (i.e., 14 semesters plus the intervening summers- plus one additional summer to finish if necessary) is the maximum time allowed to complete the Ph.D. in the Mathematics Department. An additional year may be allowed if requested by the student's Advisory Committee and approved by the department's Graduate Committee. Any exceptions to this policy will require approval by the Department Head.

M. Financial Support

For those who qualify, continued financial support from the Department of Mathematics will depend on satisfactory academic progress and satisfactory performance in teaching and/or research duties as well as available funds. Five years is the maximum period that qualified students will be able to receive departmental financial support. Beyond the five year mark, students continuing in the Ph.D. program who maintain satisfactory academic progress and satisfactory performance in teaching and/or research duties may be given teaching assignments (if qualified) at the part-time instructor or hourly rate granted that funds are available. Students receiving departmental financial support are expected to attend graduate student seminars, colloquium events, and other departmental events as suggested by the Director of Graduate Programs and their Ph.D. advisor. See section IV (B) for more information on the requirements for students on departmental financial support.

For students who successfully pass the qualifying examinations, the department reserves a fixed amount of money for student travel for professional development. These funds may be used only after the Advanced Topics Examination (see section III (G)) is complete. Students must receive approval from their Ph.D. advisor prior to using these funds. When possible, students are encouraged to use the funds closer to graduation in conjunction with the job search. For additional funding opportunities on student support for travel and conferences, students are encouraged to contact their faculty advisor as well as the School of Science Graduate Student Council and IUPUI Graduate and Professional Student Government.

N. Research in Absentia

Research in absentia is possible only for students who have fulfilled the following requirements and are well into a research program: Qualifying Exams, Foreign Language Exam, Plan of Study, Advanced Topics and Preliminary Exam. A request for permission from the Math Department to do research in absentia requires the approval of the Ph.D. Advisor, the Director of Graduate Programs, and the Purdue Graduate School. This form must be filed two months prior to the start of the session in which research in absentia registration is requested. Refer to the Policies and Procedures Manual for Administering Graduate Student Programs for further information.

O. Normal Progress and Termination

Students are expected to continually enroll in coursework once they begin the research phase. If a student takes a break from study, it is important to note that courses taken prior to a five year gap may not count towards the degree. Students who are inactive for three or more academic sessions must submit a new application.

Since an overall GPA of 3.0 out of 4.0 is required by the department for graduation, a student is automatically considered to be on academic probation if at any time the cumulative index falls below 3.0. Two semesters of work under the 3.0 index will generally result in the loss of program financial support such as teaching and research assistantships if applicable. Moreover, after two semesters of work under the 3.0 index, students will

not be permitted to register for additional courses without permission from the Department Chair in consultation with the Director of Graduate Programs.

In addition to academic success, students are responsible for reading and abiding by the Student Code of Conduct. If students do not abide by the Student Code of Conduct, they may face disciplinary action which includes, but is not limited to, dismissal from their academic program.

If students find it necessary to withdraw from the graduate program, then they should provide as much notice as possible to the Director of the Graduate Program. In the case of teaching assistants, students are expected to complete the semester once it has begun. Similarly, the department will provide a student with as much advance notice as possible if the student is dropped from the program for reasons of poor performance.

P. Program Forms and Paperwork

Throughout the period of enrollment in the Ph.D. program, certain forms must be filled out at specified points in the program. It is the student's responsibility to complete the forms at the appropriate times, as required. Below is a list of all required forms with an explanation. All forms must be filed with the Graduate Programs Coordinator in the Math Department.

Report of Foreign Language Examination

The Report of Foreign Language Examination form must be completed by both the student and the individual administering the examination, and signed by the administrator of the exam, the student's advisor, and the Director of Graduate Programs upon successful completion of the exam. See section III (E) for more details on this examination.

Doctoral Plan of Study (Form GS-4)

The Doctoral Plan of Study should be filed after successful completion of the Qualifying Examination and at least two months before the Advanced Topics Examination. Please follow the Instructions for Submitting the Plan of Study before submitting the form to the Graduate Programs Coordinator. See section III (F) for more details on the plan of study.

Request for Change to the Plan of Study (Form GS-13)

The Request for Change to the Plan of Study form must be submitted if anything on the previously approved plan of study changes, such as a course not completed or completed in a different semester than originally planned, etc.

Advanced Topics Examination Proposal

The Advanced Topics Examination Proposal form must be completed by the student and Graduate Faculty member serving as the Advanced Topics Examination Coordinator. It should be submitted to the Graduate Programs Coordinator at least two months in advance of the exam. It is signed by the student, the Advanced Topics Coordinator, and the Director of Graduate Programs. See section III (G) for more details on this examination.

Report of Advanced Topics Examination

The Report of Advanced Topics Examination form must be submitted immediately upon successful completion of the examination. It is signed by each committee member and the Director of Graduate Programs.

Request for Appointment of Preliminary Examination Committee (Form GS-8)

The Request for Appointment of Preliminary Examination Committee form must be completed by the student and Ph.D. Advisor. It should be submitted to the Graduate Programs Coordinator at least two months in advance of the exam. It is signed by the Ph.D. Advisor and the Director of Graduate Programs. See section III (H) for more details on this examination.

Report of the Preliminary Examination (Form GS-10)

The Report of the Preliminary Examination form will be submitted by the Graduate Programs Coordinator in the Math Department immediately upon successful completion of the examination. This form must be on file with the Purdue Graduate School at least one full year in advance of the student's intended graduation session.

Request for Appointment of Final Examination Committee (Form GS-8)

The Request for Appointment of Final Examination Committee form must be completed by the student and Ph.D. Advisor. It should be submitted to the Graduate Programs Coordinator at least two months in advance of the exam. It is signed by the Ph.D. Advisor and the Director of Graduate Programs. See section III (J) for more details on this examination.

Report of the Final Examination (Defense) (Form GS-11)

The Report of the Final Examination form is signed by the members of the Final Examination Advisory Committee and the Director of Graduate Programs upon successful completion of the Final Examination (Defense).

IV. POLICIES FOR STUDENTS RECEIVING DEPARTMENTAL FINANCIAL SUPPORT

A. SALARY AND GRADUATE STUDENT ASSIGNMENT DETERMINATION

Decisions on the yearly salaries of graduate students on Student Academic Appointments (SAA) are based on students' satisfactory progress toward an advanced degree as well as the achievement of previous assignments. Students on SAA are expected to work up to 20 hours per week during the fall and spring semesters. Students on SAA who are given an 11- or 12-month salary are also expected to work up to 10 hours per week during one of the summer sessions. Assignments are awarded based on experience. Typically, assignments are given in the following order:

1) Grading and Proctoring
2) Tutoring
3) Leading a Recitation
4) Teaching a Course

Teaching assignments are not typically given to first year students. However, if a student enters the Ph.D. program with previous teaching experience, the student may be found qualified to teach in the first year. All

supported students are expected to enroll in MATH 49500 "TA Instruction" each fall semester until they are exempt from this course by the Part-time Teaching Coordinator and the Director of Graduate Programs. (NOTE: All Ph.D. students on departmental financial support will be expected to teach at some point in their program.)

B. EXPECTATIONS

Continuation of departmental financial support will be dependent on the following:

1) Satisfactory Academic Progress
   a) Must maintain a minimum cumulative GPA of 3.0 with satisfactory completion of all core courses
   b) Continued active progress towards degree
   c) Ph.D. students are expected to successfully pass the Qualifying Exams and Advanced Topics Exams by the specified deadlines indicated in sections III (C) and (G).
2) Acceptable performance on previous assignments (grading, tutoring, teaching, etc.)
3) Attendance and participation at departmental events such as the weekly Graduate Student Seminars and Colloquium events (see section VI (A)).
4) Successful completion of MATH 49500 each fall semester
5) Provide assistance as a substitute instructor and proctor as needed
6) Maintain full-time status (a minimum of 8 credit hours for students on fellowship or a minimum of 6 credit hours for students on SAA)
7) Non-native English speakers must successfully complete the requirements of the SPEAK test (see section V (B)) within the first year of admission

If any of these expectations are not met, departmental financial support may be terminated at any time.

V. INTERNATIONAL AND NON-NATIVE ENGLISH SPEAKING STUDENT AFFAIRS

A. ENGLISH FOR ACADEMIC PURPOSES (EAP)

All international students who have not completed a degree within the U.S. or an approved English speaking country are expected to take the English for Academic Purposes (EAP) test upon arrival to IUPUI (usually during the Office of International Affairs Orientation session the week before the semester begins). Students may refer to the admission letter from the Office of International Affairs to determine if the EAP test is required. Students may contact the Graduate Programs Coordinator to locate the results of the EAP exam. If a particular English course(s) is recommended by the EAP Office, the course(s) must be successfully completed as soon as possible. If the EAP recommended course(s) is not completed, the student will not be permitted to graduate. Keep in mind, though, that the Math Department is unable to fund any courses required by the EAP test. Therefore, the student is solely responsible for paying the fees and tuition for any required English courses (even for those who are supported by the department).

If a student performs poorly on the EAP test, the student may be eligible to retest at a future test date. Please see the Department of English EAP Retesting Policy for further details. More information on this exam can be located on the Department of English website.

B. SPEAK TEST

All graduate students at IUPUI whose first language is not English must be tested for oral English language competency before they are given any appointments having direct student contact, including positions such as teaching assistants as well as tutors. This policy was passed by the IUPUI Graduate Affairs Committee.

Students' oral language proficiency will be assessed using the SPEAK Test, which is published by ETS (publishers of the TOEFL). A description of the SPEAK Test can be found on the English Department website.

This test is in addition to the EAP Placement test (see section V (A)), which is required of international students upon entering IUPUI. The SPEAK Test must be taken and passed before the student is given an academic appointment.

All supported students are expected to take and pass the SPEAK test within their first year of admission to the graduate program in order to continue departmental financial support for future years. The Math Department will sponsor the initial SPEAK test fee for supported students' first attempt. After the first attempt, if the student wishes to retest, s/he will need to pay out of pocket. The SPEAK test may only be taken up to 3 times.

The SPEAK test is typically offered prior to the start of the fall and spring semesters. However, dependent on request, the SPEAK test may be offered more frequently. Students are encouraged to prepare prior to taking the SPEAK test by reviewing sample exams found on the English Department's website.

C. Enrollment Requirement

All international students on F-1 or J-1 visas must maintain full-time enrollment. Full-time enrollment consists of a minimum of eight credit hours of coursework for non-supported students and those on a fellowship. Full-time enrollment for supported students on an SAA (see section IV) consists of a minimum of six credit hours of coursework. It is very important that international students abide by these guidelines to ensure their visas do not become inactive. Other guidelines can be located in the Handbook for International Students and Scholars.

International students are encouraged to maintain close contact with the Office of International Affairs for rules and regulations concerning visa status.

VI. Miscellaneous

A. Graduate Student Seminars & Colloquium

Every fall and spring semester, the IUPUI Department of Mathematical Sciences offers a Graduate Student Seminar course (usually MATH 59800 and STAT 59800). This course is typically offered once a week and provides students and faculty the opportunity to discuss their research findings or present on advanced topics. All graduate students who are financially supported by the department are expected to attend the Graduate Student Seminar course each semester (fall and spring) to gain knowledge and experience in presenting research findings or advanced topics. All pure and applied math students are expected to attend the MATH 59800 course and all statistics students are expected to attend the STAT 59800 course.

In addition to the Graduate Student Seminar course, the IUPUI Department of Mathematical Sciences offers a Colloquium event once a week that typically falls on Fridays from 3:30-4:30 p.m. The Colloquium events feature guest speakers from various institutions who provide a talk on their research. All graduate students who are financially supported by the department are expected to attend a minimum of five Colloquium events to gain knowledge in a variety of different areas of research. Supported graduate students will be expected to record their attendance of the Colloquium events and submit this record to their faculty advisor and the Graduate Programs Director for approval.

B. Transfer and Outside Elective Coursework

Transfer Coursework

For a student in the M.S. program, up to 12 credit hours of coursework completed at another institution may be counted towards the IUPUI M.S. degree, contingent on faculty approval. For a student in the Ph.D. program, transfer coursework is not accepted by the Purdue University Mathematics Department unless completed for a master's degree. A maximum of 30 credit hours of coursework completed for a master's degree may apply towards the IUPUI Ph.D. degree, upon advisor approval. No paperwork is needed for students transferring master's hours to their Ph.D. degree unless requested by the faculty advisor. Instead, the student may have the faculty advisor make a statement on the Plan of Study to indicate that a specified number of credit hours (up to 30) of coursework from the master's degree apply to the Ph.D. (see section III (F)).

Students in the M.S. program submit the Petition for Approval of Transfer Course form to their faculty advisor in order to initiate an appeal process and receive approval to apply a course completed at a different institution towards their degree. Students must provide, at minimum, the syllabus for the course under evaluation. Other documentation may be requested, as needed.

If the transfer course is considered acceptable, the student will need to complete the top portion (everything above the signature lines) of the IUPUI Graduate Credit Transfer Report Form and the faculty advisor will need to sign as the "Authorized Representative." Then, the Graduate Credit Transfer Report Form will need to be submitted to the Graduate Programs Coordinator along with the Petition of Approval of Transfer Course form. The Graduate Programs Coordinator will then retrieve additional signatures from the Director of the Graduate Programs as well as the Graduate Dean.

Outside Elective Coursework

Students submit the Petition for Approval of Outside Elective Course form in order to initiate an appeal process and receive approval to apply a course completed in a different department towards their degree. Students must provide, at minimum, the syllabus for the course under evaluation. Other documentation may be requested, as needed. Students should submit this petition *prior* to taking the course if possible as there is no guarantee that the course will be accepted as an elective until reviewed by the faculty advisor and Graduate Programs Director.

Course Revalidation

Students in the M.S. program who have been inactive for more than 5 consecutive years will need to submit a Course Revalidation Form in order to be able to use previous courses for their degree. Students in the Ph.D. program whose graduate study and/or professional activity has been inactive for five years or more cannot use previous courses for this degree. A preliminary examination passed prior to such a period of inactivity is invalid.

Courses taken as Graduate Non-Degree Status

Students may apply up to 12 credits hours of coursework earned as non-degree status towards the master's degree (usually taken prior to entering the graduate program), contingent on faculty approval. The courses, if approved, should be listed on the student's plan of study and marked as "Non-degree Registration." No additional paperwork is necessary to apply these courses. However, students are responsible for connecting with their faculty advisor early on in their program to determine whether or not these courses may apply toward their degree.

C. University Email Policy

The IUPUI Department of Mathematics maintains an official graduate student e-mail list. As stated in the IUPUI campus-wide email policy, communication with students will be through IUPUI email. It is very

important that all graduate student read their IUPUI email, as the emails will contain important details concerning degree requirements, graduation deadlines, etc.

More information on how to setup and manage the university email account can be found on the Account Management Service website. University Information and Technology Services (UITS) may provide further assistance for any technical difficulties (317-274-4357).

D. Emergency Preparedness Policy

IUPUI has created an Emergency Preparedness website as part of the campus's ongoing emergency preparedness efforts. In the event of a disaster or emergency, this site will contain regularly updated news, instructions, and information. Of particular importance is the IU-Notify system, which provides important announcements via text message, email, and/or voicemail. The "Keep Informed" section of the website provides more information on this and on registering for IU-Notify.

E. Requesting Topics or Research Courses

In order to request a Topics (59800) or Research/Thesis (69900 or 69800) course with a particular instructor, students must first obtain approval from an instructor and determine a title (if applicable) for the course. Then, students may submit an electronic course request (including the number of credit hours) and a new course will be created for them.

F. Process of Earning M.S. While Obtaining Ph.D.

Students directly admitted to the Ph.D. program without having earned a master's degree in their related area are encouraged to earn their master's while working towards the Ph.D. There are no additional course requirements for Ph.D. students to earn their master's degree at IUPUI. However, there are additional forms that are required. Once Ph.D. students successfully complete their Qualifying Examinations (see section III (C)), they may start the application process for the master's program without having to pay any application fees.

a. Students must create an online application for their master's program of choice (within mathematics or statistics)
b. Once the application is complete but not yet submitted, students must contact the Graduate Programs Coordinator
c. The Graduate Programs Coordinator will work with the School of Science Graduate Dean, the IUPUI Graduate Office, and the Office of International Affairs (if an international student) to submit the fee waiver for the application
d. Once submitted and processed, the student will be notified of their admission to the program and will complete steps D-F in section II of this handbook.
e. Once the student "graduates" with the M.S. degree, the student will continue in the Ph.D. program until complete

VII. Syllabus for Ph.D. Qualifying Examinations

Examinations will be based on material listed below for each area. A list of the principal topics in each area is presented as an overview, but not as a detailed outline of the reference material. Previous exams are available on the Math Department website.

Real Analysis (MATH 54400)

Topics:

(a) Topology of $\mathbb{R}$ (open, closed, compact, connected, category).
(b) Continuity, semi-continuity, sequences of continuous functions and types of convergence, equicontinuity and compactness in C[0; 1], Stone-Weierstrass theorem.
(c) Construction of Lebesgue measure on $\mathbb{R}$, abstract measure spaces, the Lebesgue integral.
(d) Differentiation: (i) Bounded variation and Helly Selection Theorem, (ii) Vitali Covering Theorem, differentiation of monotone functions, absolute continuity and the fundamental Theorem of Calculus.

Books:

For (a) and (b):
W. Rudin, *Principles of Mathematical Analysis*
R. Bartle, *The Elements of Real Analysis*
Natanson, *Theory of Functions of a Real Variable, v.I.*
For (c):
W. Rudin, *Real and Complex Analysis*
A. Torchinsky, *Real Variables*
H.L. Royden, *Real Analysis*
For (d):
Natanson, Torchinsky, and Royden

Abstract Algebra (MATH 55300)

Prerequisites:

Some undergraduate level linear algebra and group theory such as is found on pages 1-99 of M. Artin's Algebra and, in addition, D&F (see below), Chapters 0-3 (except §3.4).

Topics:

(a) Group theory; Sylow theorems; Jordan-Hölder theorem; solvable groups. [D&F, Chapters 4-5, plus §3.4].
(b) Ring theory; unique factorization in polynomial rings and principal ideal domains. [D&F, Chapters 7-9].
(c) Field theory; ruler and compass constructions, roots of unity, finite fields, Galois theory; solvability of equations by radicals. [D&F, Chapters 13-14, up to and including 14.7].

Book:

[D&F]: D. Dummit and R. Foote, *Abstract Algebra*, 2nd Edition

Complex Analysis (MATH 53000)

Topics:

(a) Cauchy-Riemann equations; conformality and other properties of analytic functions; linear fractional transformations; special functions.
(b) Taylor and Laurent series; absolute and uniform convergence.
(c) Cauchy's theorem, formula, residue theorem, inequality; Morera's theorem; classification of singularities; Liouville's theorem; fundamental theorem of algebra; Casorati-Weierstrass theorem; definite integrals; maximum modulus theorem; Schwarz's lemma; Rouche's theorem; Weierstrass' theorem.
(d) Harmonic functions; Poisson formula, Schwarz's theorem; harmonic conjugates; reflection principle.

Book:

Ahlfors, *Complex Analysis*, 3rd Edition, pp. 1-48, 67-84, 101-186

Linear Algebra (MATH 55400)

Topics:

(a) Vector spaces; linear maps; matrices; determinants; systems of linear equations.
(b) Inner products; hermitian, unitary and normal operators.
(c) Modules over a principal ideal domain; finitely generated abelian groups; Jordan and rational canonical forms for a linear transformation.

Books:

Hoffman and Kunze, *Linear Algebra*, Chapters 1-8 (omitting §§5.6, 5.7)
Jacobson, *Basic Algebra I*, Chapter 3 (omit §3.11)

Numerical Analysis (MATH 51400/59800)

Topics:

(a) Machine Arithmetic, Error Propagation and the Conditioning of Problems: real numbers, machine numbers, rounding; machine arithmetic; propagation of rounding errors, cancellation errors; conditioning of problems, examples.
(b) Approximation and Interpolation: least squares approximation and data fitting; orthogonal polynomials; polynomial interpolation, Lagrange's formula; interpolation error and convergence; interpolation at Chebyshev points, Chebyshev polynomials; Newton's form of the interpolation polynomial; Hermite interpolation; inverse interpolation; interpolation by means of spline functions, minimal properties of spline interplant's.
(c) Numerical Differentiation and Integration: finite difference approximation of derivatives; numerical integration by composite trapezoidal and Simpson rules; Newton-Cotes formulae; Gaussian quadrature formulae; approximation of linear functionals, methods of interpolation and undetermined coefficients; extrapolation methods, Romberg integration.
(d) Nonlinear Equations: examples; iterative methods, order of convergence; bisection method; secant method and its convergence properties; Newton's method, local and global convergence; algebraic equations; systems of nonlinear equations (briefly).
(e) Ordinary Differential Equations: one-step methods, local and global error; Runge-Kutta methods; stiff equations; multistep methods.

Books:

G. Dahlquist & A. Björck, *Numerical Methods*
J. Stoer & R. Bulirsch, Introduction to Numerical Analysis

Partial Differential Equations (MATH 52300)

Topics:

(a) Integral curves and surfaces of vector fields; Quasi-linear and linear equations of first order.
(b) Characteristics; classification; canonical forms.
(c) Separation of variables; Sturm-Liouville problems; Fourier series and convergence theorems.
(d) Equations of mathematical physics; Laplace equation; wave equation; heat equation.
(e) Cauchy-Kowalewski theorem; Holmgren Uniqueness theorem.

Books:

Churchill and Brown, *Fourier Series and Boundary Value Problems*, 4th Edition, Chapters 2, 3, 4
Zachmanoglou and Thoe, *Introduction to Partial Differential Equations*, Chapters 2, 3, 4, 5-10
John, *Partial Differential Equations*

Chapter 1 : §§ 1-6

Chapter 2 : §§ 1-4
Chapter 3 : §§ 1-6
Chapter 4 : §§ 1-3
Chapter 5 : § 1
Chapter 7 : § 1

Differential Geometry (MATH 56200)

Prerequisites:

Some undergraduate multivariate calculus and topology as found in Munkres, Chapters 1-4 (see below) including the topology of $\mathbb{R}^n$, the chain rule for mappings from $\mathbb{R}^n$ into $\mathbb{R}^m$, the implicit and inverse function theorems, and Jacobians.

Topics:

(a) Differentiable manifolds and submanifolds; differentiable mappings, rank of a mapping and immersions, submanifolds, tangent and cotangent bundles.
(b) Vector fields, Lie groups, One parameter groups, Lie bracket, Frobenius' theorem.
(c) Tensors and tensor fields on manifolds; exterior algebra, orientation, integration on manifolds, Stokes' Theorem on manifolds.

Books:

J. Munkres, *Analysis on Manifolds*, Chapters 1-4
W. Boothby, *Differentiable Geometry and Riemannian Geometry*, Chapters 1-6

Topology (MATH 57100)

Topics:

(a) Infinite products, Zorn's Lemma and equivalent statements, topological and metric spaces, open and closed sets, continuous mappings, constructions on spaces.
(b) Connectedness and path connectedness, compactness, Urysohn's Lemma and its consequences, special properties of metric spaces.
(c) Tychonoff's Theorem, compactifications, local finiteness and paracompactness, complete metric spaces and Baire's Theorem, compact open topologies on function spaces.
(d) Homotopy theory of closed curves, fundamental groups, classical implications for plane topology, classification of covering spaces.

Books:

Munkres, *Elementary Topology*, Chapters 1-5, §4.6, §4.8, Chapter 9, and Chapter 13
Jänich, *Topology*, Chapters 1, 3-6, 8-10 and Last Chapter, (omitting §§4.3, 5.4-5.7, 8.4, 10.2)

Probability (STAT 51900)

Topics:

(a) Probability spaces and axioms; probability laws; conditional probabilities and independence
(b) Combinatorial analysis.
(c) Discrete random variables.
(d) Continuous random variables.
(e) Jointly distributed random variables; distributions of functions of random variables.

(f) Expectations, variance, moments.
(g) Jointly normal random variables in detail.
(h) Limit theorems (e.g., weak law of large numbers and the central limit theorem with its applications); the delta method.
(i) Generating a random sample; distributions of order statistics.

Books:

Hogg, McKean, and Craig, *Introduction to Mathematical Statistics*, Chapters 1-4 (omitting sections 3.5 and 4.5); Sections 5.1, 5.2 and 5.8
Casella and Berger, *Statistical Inference*, Chapters 1-5 (omitting sections 4.4 and 4.7)
Dudewicz and Mishra, *Modern Mathematical Statistics*, Chapters 1-6
Hoel, Port, and Stone, *Introduction to Probability*, Chapters 1-8, (omitting 2.7, 2.8, 5.4, 8.2, 8.3)

Mathematical Statistics (STAT 52800)

Topics:

(a) Convergence in probability/distribution; delta method; central limit theorem.
(b) Sampling; order statistics.
(c) Confidence intervals.
(d) Hypothesis testing.
(e) Monte Carlo method; bootstrap procedures.
(f) Maximum likelihood methods; Rao-Cramer lower bound and efficiency.
(g) (Minimal) sufficiency; completeness and uniqueness; exponential family; minimum variance unbiased estimator; ancillary statistics; independence.
(h) (Uniformly) most powerful tests; likelihood ratio tests; unbiased tests.

Books:

Hogg, McKean and Craig, *Introduction to Mathematical Statistics*, Chapters 4-8 (omitting sections 4.5, 5.3, and 8.5)
Casella and Berger, *Statistical Inference*, Chapters 5-9 (omitting sections 6.3, 6.4; omitting subsections 7.2.3, 7.2.4, 7.3.4, 8.2.2, 8.2.3, 8.3.3, 8.3.5, 9.2.4, 9.3.3 and 9.3.4); Subsections 10.1.1–10.1.3
Dudewicz and Mishra, *Modern Mathematical Statistics*, Chapters 5-10 (omitting sections 9.10 and 10.8)

VIII. GRADUATE MATHEMATICS COURSES

A course listing and course availability can be found on the Math Department website. Please note that certain MATH/STAT courses are not offered in every semester. Therefore, it is very important to plan courses early on to ensure sufficient progress is made in the program.

Master Schedule of Courses

Students should plan their courses around the Master Schedule of Courses. All required courses should be listed on this site. However, there may be certain courses that are not listed. Students are recommended to meet with their advisor when planning courses each semester. If a course is desired but not offered in any particular semester, it may be possible to offer the course as a Topics course (such as MATH 59800 or STAT 59800). See section IV (E) for more information on how to submit an electronic course request.